

**METHODS AND COMPOSITIONS FOR
TREATING GASTROPIARESIS**

FIELD OF THE INVENTION

The invention relates to compositions that can ameliorate or prevent gastroparesis and are useful as dietary supplements (e.g., health drinks) or medication (e.g., pills). These compositions contain yeast cells obtainable by growth in electromagnetic fields with specific frequencies and field strengths.

BACKGROUND OF THE INVENTION

Gastroparesis is a common condition. The upper portion of a human stomach generates electrical waves that sweep across the antrum, causing the stomach to contract, to grind food and to empty food into the intestines. Gastroparesis occurs when the rate of the electrical waves slow and the stomach muscles contract less frequently. Common symptoms of gastroparesis include nausea, vomiting, a feeling of fullness after only a few bites of food, bloating, and excessive belching.

Gastroparesis is caused by either diseases of the stomach muscles or the nerves that control these muscles. It is commonly associated with diabetes mellitus, which damages the nerves controlling the stomach muscle. Other causes include nervous reflexes, imbalance of potassium, calcium or magnesium, certain medications and certain diseases. Scars and fibrous tissue from ulcers and tumors that block the outlet of the stomach can mimic gastroparesis.

Gastroparesis is diagnosed based on symptoms and physical examination. A gastric emptying study is the most common method to measure the emptying of food from the stomach. An Upper gastrointestinal endoscopy test is another common examination to exclude the possibility of an obstruction as the cause of the patient's symptoms. An antro-duodenal motility study measures the pressure that is generated by the contractions of the stomach and intestinal muscles. Another test is an electrogastrogram (EGG), which records the electrical signals that travel through the stomach muscles and control the muscles' contractions. The electrical signals normally precede each contraction. In most patients, the rhythm of the electrical signals is either irregular or there is no post-meal increase in electrical power. Although an EGG does not measure gastric emptying directly, it is an attractive test for suspected gastroparesis.

Currently available medications treat gastroparesis by stimulating the stomach to contract more normally. Metoclopramide is an effective medication that has side effects such as restlessness, fatigue, agitation and depression. Another drug is domperidone, which has not been approved in the United States. The third drug is erythromycin, which stimulates short bursts of strong contractions that are more like the contractions that sweep undigested food into the colon than regular digestive contractions. Like erythromycin, octreotide, a hormone-like drug, can be injected underneath the skin to stimulate short bursts of strong contraction. The last resort is surgery, which is occasionally used to create a larger opening between the stomach and the small intestine in order to facilitate the process of emptying the stomach.

Gastroparesis may become worse with time. Motility disorders of the muscles of the small intestine and colon make gastroparesis difficult to treat. There remains a need for an effective treatment for gastroparesis.

SUMMARY OF THE INVENTION

This invention is based on the discovery that certain yeast cells can be activated by electromagnetic fields having specific frequencies and field strengths to produce substances useful in treating gastroparesis. Compositions comprising these activated yeast cells can therefore be used as medication, or

dietary supplements in the form of health drinks or dietary pills (tablets or powder). For instance, these compositions can be used to alleviate gastroparesis symptoms in a human patient, or to prevent or postpone the onset of gastroparesis in a high risk individual (e.g., someone predisposed to gastroparesis because of his health or life style).

This invention embraces a composition comprising a plurality of yeast cells that have been cultured in an alternating electric field having a frequency in the range of about 9500 to 13500 MHz (e.g., 9500-10500, 11700-12700 and 12200-13200 MHz) and a field strength in the range of about 200-450 mV/cm (e.g., 235-255, 240-260, 250-270, 255-275, 265-285, 275-295, 280-300, 290-310, 290-320, 330-350 and 360-380 mV/cm). The yeast cells are cultured for a period of time sufficient to activate said plurality of yeast cells to produce substances useful in treating gastroparesis in a subject. In one embodiment, the frequency and/or the field strength of the alternating electric field can be altered within the aforementioned ranges during said period of time. In other words, the yeast cells are exposed to a series of electromagnetic fields. An exemplary period of time is about 10-50 hours.

Also included in this invention is a composition comprising a plurality of yeast cells that have been cultured under acidic conditions in an alternating electric field having a frequency in the range of about 10010-12800 MHz (e.g., 12600-12780 MHz) and a field strength in the range of about 235 to 380 mV/cm (e.g., 280-330 mV/cm). In one embodiment, the yeast cells are exposed to a series of electromagnetic fields. An exemplary period of time is about 10-100 hours.

Yeast cells that can be included in this composition can be derived from parent strains available from the China General Microbiological Culture Collection Center ("CGMCC"), China Committee for Culture Collection of Microorganisms, Institute of Microbiology, Chinese Academy of Sciences, Haidian, P.O. Box 2714, Beijing, 100080, China. Useful yeast species include, but are not limited to, those commonly used in food and pharmaceutical industries, such as *Saccharomyces sp.*, *Schizosaccharomyces pombe*, *Saccharomyces sake*, *Saccharomyces uvarum*, *Saccharomyces rouxii*, *Saccharomyces cerevisiae*,

Saccharomyces carlsbergensis, *Rhodotorula aurantiaca* and *Rhodotorula rubar*. For instance, the yeast cells can be of the strain *Saccharomyces cerevisiae* Hansen AS2.559, *Saccharomyces* sp. AS2.311, *Schizosaccharomyces pombe* Lindner AS2.994, *Saccharomyces sake* Yabe ACCC2045, *Saccharomyces uvarum* Beijer 5 IFFI1044, *Saccharomyces rouxii* Boutroux AS2.180, *Saccharomyces cerevisiae* Hansen Var. *ellipsoideus* AS2.612, *Saccharomyces carlsbergensis* Hansen AS2.377, *Rhodotorula rubar* (Demme) Lodder AS2.282 and *Saccharomyces cerevisiae* Hansen AS2.69. Other useful yeast strains are illustrated in Table 1.

This invention further embraces a composition comprising a 10 plurality of yeast cells, wherein said plurality of yeast cells have been activated to treat gastroparesis in a subject. Included in this invention are also methods of making these compositions.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in 15 the art to which this invention belongs. Exemplary methods and materials are described below, although methods and materials similar or equivalent to those described herein can also be used in the practice or testing of the present invention. All publications and other references mentioned herein are incorporated by 20 reference in their entirety. In case of conflict, the present specification, including definitions, will control. The materials, methods, and examples are illustrative only and not intended to be limiting. Throughout this specification and claims, the word “comprise,” or variations such as “comprises” or “comprising” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers. A subject includes a human 25 and veterinary subject.

Other features and advantages of the invention will be apparent from the following detailed description, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing an exemplary apparatus for 30 activating yeast cells using electromagnetic fields. 1: yeast culture; 2: container; 3: power supply.

Fig. 2 is a schematic diagram showing an exemplary apparatus for making yeast compositions of the invention. The apparatus comprises a signal generator and interconnected containers A, B and C.

Figs. 3 shows representative EGGS. A represents an 5 electrogastrogram of rabbits before feeding; B represents an electrogastrogram of rabbits in the AY group at 60 minutes after feeding; C represents an electrogastrogram of rabbits in the NY group at 60 minutes after feeding; and D represents an electrogastrogram of rabbits in the CK group at 60 minutes after feeding.

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DETAILED DESCRIPTION OF THE INVENTION

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This invention is based on the discovery that certain yeast strains can be activated by electromagnetic fields (“EMF”) having specific frequencies and field strengths to become highly efficient in producing substances that increase the bioelectrical activities of the stomach, reduce abnormal gastric acid secretion and/or abnormal pepsin production in a subject. Compositions containing these activated yeast cells are therefore useful in the treatment of gastroparesis. Yeast compositions containing activated yeast cells can be used as medication or dietary supplements.

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Since the activated yeast cells contained in the yeast compositions have been cultured to endure acidic conditions (pH 2.5-4.2), these cells can survive the gastric environment and pass on to the intestines. Once in the intestines, the yeast cells are ruptured by various digestive enzymes, and the anti-gastroparesis substances are released and readily absorbed.

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I. Yeast Strains Useful in the Invention

The types of yeasts useful in this invention include, but are not limited to, yeasts of the genera *Saccharomyces*, *Schizosaccharomyces*, and *Rhodotorula*.

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Exemplary species within the above-listed genera include, but are not limited to, those illustrated in Table 1. Yeast strains useful for this invention can be obtained from laboratory cultures, or from publically accessible culture depositories, such as CGMCC and the American Type Culture Collection, 10801

University Boulevard, Manassas, VA 20110-2209. Non-limiting examples of useful strains (with accession numbers of CGMCC) are *Saccharomyces cerevisiae* Hansen AS2.559 *Saccharomyces* sp. AS2.311, *Schizosaccharomyces pombe* Lindner AS2.994, *Saccharomyces sake* Yabe ACCC2045, *Saccharomyces uvarum* 5 *Beijer* IFFI1044, *Saccharomyces rouxii* *Boutroux* AS2.180, *Saccharomyces cerevisiae* Hansen Var. *ellipsoideus* AS2.612, *Saccharomyces carlsbergensis* Hansen AS2.377, *Rhodotorula rubar* (Demme) Lodder AS2.282 and *Saccharomyces cerevisiae* Hansen AS2.69. Other useful yeast strains are illustrated in Table 1.

10 Although it is preferred, the preparation of the yeast compositions of this invention is not limited to starting with a pure strain of yeast. A yeast composition of the invention may be produced by culturing a mixture of yeast cells of different species or strains. The ability of any activated species or strain of yeasts to treat gastroparesis can be readily tested by methods known in the art. See, 15 for instance, Examples 1 and 2.

Table 1 Exemplary Yeast Strains

<i>Saccharomyces cerevisiae</i> Hansen					
	ACCC2034	ACCC2035	ACCC2036	ACCC2037	ACCC2038
	ACCC2039	ACCC2040	ACCC2041	ACCC2042	AS2. 1
5	AS2. 4	AS2. 11	AS2. 14	AS2. 16	AS2. 56
	AS2. 69	AS2. 70	AS2. 93	AS2. 98	AS2. 101
	AS2. 109	AS2. 110	AS2. 112	AS2. 139	AS2. 173
	AS2. 174	AS2. 182	AS2. 196	AS2. 242	AS2. 336
	AS2. 346	AS2. 369	AS2. 374	AS2. 375	AS2. 379
10	AS2. 380	AS2. 382	AS2. 390	AS2. 393	AS2. 395
	AS2. 396	AS2. 397	AS2. 398	AS2. 399	AS2. 400
	AS2. 406	AS2. 408	AS2. 409	AS2. 413	AS2. 414
	AS2. 415	AS2. 416	AS2. 422	AS2. 423	AS2. 430
	AS2. 431	AS2. 432	AS2. 451	AS2. 452	AS2. 453
15	AS2. 458	AS2. 460	AS2. 463	AS2. 467	AS2. 486
	AS2. 501	AS2. 502	AS2. 503	AS2. 504	AS2. 516
	AS2. 535	AS2. 536	AS2. 558	AS2. 560	AS2. 561
	AS2. 562	AS2. 576	AS2. 593	AS2. 594	AS2. 614
	AS2. 620	AS2. 628	AS2. 631	AS2. 666	AS2. 982
20	AS2. 1190	AS2. 1364	AS2. 1396	IFFI1001	IFFI1002
	IFFI1005	IFFI1006	IFFI1008	IFFI1009	IFFI1010
	IFFI1012	IFFI1021	IFFI1027	IFFI1037	IFFI1042
	IFFI1043	IFFI1045	IFFI1048	IFFI1049	IFFI1050
	IFFI1052	IFFI1059	IFFI1060	IFFI1062	IFFI1063
25	IFFI1202	IFFI1203	IFFI1206	IFFI1209	IFFI1210
	IFFI1211	IFFI1212	IFFI1213	IFFI1214	IFFI1215
	IFFI1220	IFFI1221	IFFI1224	IFFI1247	IFFI1248
	IFFI1251	IFFI1270	IFFI1277	IFFI1287	IFFI1289
	IFFI1290	IFFI1291	IFFI1292	IFFI1293	IFFI1297
30	IFFI1300	IFFI1301	IFFI1302	IFFI1307	IFFI1308
	IFFI1309	IFFI1310	IFFI1311	IFFI1331	IFFI1335

	IFFI1336	IFFI1337	IFFI1338	IFFI1339	IFFI1340
	IFFI1345	IFFI1348	IFFI1396	IFFI1397	IFFI1399
	IFFI1411	IFFI1413	IFFI1441	IFFI1443	
<i>Saccharomyces cerevisiae</i> Hansen Var. <i>ellipsoideus</i> (Hansen) Dekker					
5	ACCC2043	AS2.2	AS2.3	AS2.8	AS2.53
	AS2.163	AS2.168	AS2.483	AS2.541	AS2.559
	AS2.606	AS2.607	AS2.611	AS2.612	
<i>Saccharomyces chevalieri</i> Guilliermond					
10	AS2.131	AS2.213			
<i>Saccharomyces delbrueckii</i>					
	AS2.285				
<i>Saccharomyces delbrueckii</i> Lindner ver. <i>mongolicus</i> (Saito) Lodder et van Rij					
	AS2.209	AS2.1157			
<i>Saccharomyces exiguous</i> Hansen					
15	AS2.349	AS2.1158			
<i>Saccharomyces fermentati</i> (Saito) Lodder et van Rij					
	AS2.286	AS2.343			
<i>Saccharomyces logos</i> van laer et Denamur ex Jorgensen					
	AS2.156	AS2.327	AS2.335		
20	<i>Saccharomyces mellis</i> (Fabian et Quinet) Lodder et kreger van Rij				
	AS2.195				
<i>Saccharomyces mellis</i> Microellipsoides Osterwalder					
	AS2.699				
<i>Saccharomyces oviformis</i> Osteralder					
25	AS2.100				
<i>Saccharomyces rosei</i> (Guilliermond) Lodder et Kreger van Rij					
	AS2.287				
<i>Saccharomyces rouxii</i> Boutroux					
	AS2.178	AS2.180	AS2.370	AS2.371	

					<i>Saccharomyces sake</i> Yabe
					ACCC2045
					<i>Candida arborea</i>
					AS2.566
5					<i>Candida lambica</i> (Lindner et Genoud) van. Uden et Buckley
					AS2.1182
					<i>Candida krusei</i> (Castellani) Berkhout
					AS2.1045
					<i>Candida lipolytica</i> (Harrison) Diddens et Lodder
10	AS2.1207	AS2.1216	AS2.1220	AS2.1379	AS2.1398
	AS2.1399	AS2.1400			
					<i>Candida parapsilosis</i> (Ashford) Langeron et Talice Var. <i>intermedia</i> Van Rij et Verona
					AS2.491
15					<i>Candida parapsilosis</i> (Ashford) Langeron et Talice
					AS2.590
					<i>Candida pulcherrima</i> (Lindner) Windisch
					AS2.492
					<i>Candida rugousa</i> (Anderson) Diddens et Lodder
20	AS2.511	AS2.1367	AS2.1369	AS2.1372	AS2.1373
	AS2.1377	AS2.1378	AS2.1384		
					<i>Candida tropicalis</i> (Castellani) Berkhout
	ACCC2004	ACCC2005	ACCC2006	AS2.164	AS2.402
	AS2.564	AS2.565	AS2.567	AS2.568	AS2.617
25	AS2.637	AS2.1387	AS2.1397		
					<i>Candida utilis</i> Henneberg Lodder et Kreger Van Rij
	AS2.120	AS2.281	AS2.1180		
					<i>Crebrothecium ashbyii</i> (Guillermond) Routein (<i>Eremothecium ashbyii</i> Guillermond)
30	AS2.481	AS2.482	AS2.1197		

		<i>Geotrichum candidum</i> Link			
	ACCC2016	AS2.361	AS2.498	AS2.616	AS2.1035
	AS2.1062	AS2.1080	AS2.1132	AS2.1175	AS2.1183
	<i>Hansenula anomala</i> (Hansen) H et P sydow				
5	ACCC2018	AS2.294	AS2.295	AS2.296	AS2.297
	AS2.298	AS2.299	AS2.300	AS2.302	AS2.338
	AS2.339	AS2.340	AS2.341	AS2.470	AS2.592
	AS2.641	AS2.642	AS2.782	AS2.635	AS2.794
	<i>Hansenula arabitolgens</i> Fang				
10	AS2.887				
	<i>Hansenula jadinii</i> (A. et R Sartory Weill et Meyer) Wickerham				
	ACCC2019				
	<i>Hansenula saturnus</i> (Klocker) H et P sydow				
	ACCC2020				
15	<i>Hansenula schneggii</i> (Weber) Dekker				
	AS2.304				
	<i>Hansenula subpelliculosa</i> Bedford				
	AS2.740	AS2.760	AS2.761	AS2.770	AS2.783
	AS2.790	AS2.798	AS2.866		
20	<i>Kloeckera apiculata</i> (Reess emend. Klocker) Janke				
	ACCC2022	ACCC2023	AS2.197	AS2.496	AS2.714
	ACCC2021	AS2.711			
	<i>Lipomycess starkeyi</i> Lodder et van Rij				
	AS2.1390	ACCC2024			
25	<i>Pichia farinosa</i> (Lindner) Hansen				
	ACCC2025	ACCC2026	AS2.86	AS2.87	AS2.705
	AS2.803				
	<i>Pichia membranaefaciens</i> Hansen				
	ACCC2027	AS2.89	AS2.661	AS2.1039	
30	<i>Rhodosporidium toruloides</i> Banno				

	ACCC2028				
	<i>Rhodotorula glutinis</i> (Fresenius) Harrison				
	AS2.2029	AS2.280	ACCC2030	AS2.102	AS2.107
	AS2.278	AS2.499	AS2.694	AS2.703	AS2.704
5	AS2.1146				
	<i>Rhodotorula minuta</i> (Saito) Harrison				
	AS2.277				
	<i>Rhodotorula rubar</i> (Demme) Lodder				
	AS2.21	AS2.22	AS2.103	AS2.105	AS2.108
10	AS2.140	AS2.166	AS2.167	AS2.272	AS2.279
	AS2.282	ACCC2031			
	<i>Rhodotorula aurantiaca</i> (Saito) Lodder				
	AS2.102	AS2.107	AS2.278	AS2.499	AS2.694
	AS2.703	AS2.1146			
15	<i>Saccharomyces carlsbergensis</i> Hansen				
	AS2.113	ACCC2032	ACCC2033	AS2.312	AS2.116
	AS2.118	AS2.121	AS2.132	AS2.162	AS2.189
	AS2.200	AS2.216	AS2.265	AS2.377	AS2.417
	AS2.420	AS2.440	AS2.441	AS2.443	AS2.444
20	AS2.459	AS2.595	AS2.605	AS2.638	AS2.742
	AS2.745	AS2.748	AS2.1042		
	<i>Saccharomyces uvarum</i> Beijer				
	IFFI1023	IFFI1032	IFFI1036	IFFI1044	IFFI1072
	IFFI1205	IFFI1207			
25	<i>Saccharomyces willianus</i> Saccardo				
	AS2.5 AS2.7 AS2.119		AS2.152	AS2.293	
	AS2.381	AS2.392	AS2.434	AS2.614	AS2.1189
	<i>Saccharomyces</i> sp.				
	AS2.311				
30	<i>Saccharomyces ludwigii</i> Hansen				

	ACCC2044	AS2.243	AS2.508		
<i>Saccharomycodes sinenses</i> Yue					
AS2.1395					
<i>Schizosaccharomyces octosporus</i> Beijerinck					
5	ACCC2046	AS2.1148			
<i>Schizosaccharomyces pombe</i> Lindner					
	ACCC2047	ACCC2048	AS2.214	AS2.248	AS2.249
	AS2.255	AS2.257	AS2.259	AS2.260	AS2.274
	AS2.994	AS2.1043	AS2.1149	AS2.1178	IFFI1056
10	<i>Sporobolomyces roseus</i> Kluyver et van Niel				
	ACCC2049	ACCC2050	AS2.19	AS2.962	AS2.1036
	ACCC2051	AS2.261	AS2.262		
<i>Torulopsis candida</i> (Saito) Lodder					
	AS2.270	ACCC2052			
15	<i>Torulopsis famta</i> (Harrison) Lodder et van Rij				
	ACCC2053	AS2.685			
<i>Torulopsis globosa</i> (Olson et Hammer) Lodder et van Rij					
	ACCC2054	AS2.202			
<i>Torulopsis inconspicua</i> Lodder et Kreger van Rij					
20	AS2.75				
<i>Trichosporon behrendii</i> Lodder et Kreger van Rij					
	ACCC2056	AS2.1193			
<i>Trichosporon capitatum</i> Diddens et Lodder					
	ACCC2056	AS2.1385			
25	<i>Trichosporon cutaneum</i> (de Beurm et al.) Ota				
	ACCC2057	AS2.25	AS2.570	AS2.571	AS2.1374
<i>Wickerhamia fluorescens</i> (Soneda) Soneda					
	ACCC2058	AS2.1388			

II. Application of Electromagnetic Fields

An electromagnetic field useful in this invention can be generated and applied by various means well known in the art. For instance, the EMF can be generated by applying an alternating electric field or an oscillating magnetic field.

5 Alternating electric fields can be applied to cell cultures through electrodes in direct contact with the culture medium, or through electromagnetic induction. See, e.g., Fig. 1. Relatively high electric fields in the medium can be generated using a method in which the electrodes are in contact with the medium. Care must be taken to prevent electrolysis at the electrodes from introducing
10 undesired ions into the culture and to prevent contact resistance, bubbles, or other features of electrolysis from dropping the field level below that intended. Electrodes should be matched to their environment, for example, using Ag-AgCl electrodes in solutions rich in chloride ions, and run at as low a voltage as possible. For general review, see Goodman et al., *Effects of EMF on Molecules and Cells*,
15 International Review of Cytology, A Survey of Cell Biology, Vol. 158, Academic Press, 1995.

The EMFs useful in this invention can also be generated by applying an oscillating magnetic field. An oscillating magnetic field can be generated by oscillating electric currents going through Helmholtz coils. Such a magnetic field
20 in turn induces an electric field.

The frequencies of EMFs useful in this invention range from about 9500 to 13500 MHz (e.g., 9500-10500, 11700-12700 and 12200-13200 MHz). Exemplary frequencies are 10012, 10038, 12177, 12712 and 12733 MHz. The field strength of the electric field useful in this invention ranges from about 200-
25 450 mV/cm (e.g., 235-255, 240-260, 250-270, 255-275, 265-285, 275-295, 280-300, 290-310, 290-320, 330-350 and 360-380 mV/cm). Exemplary field strengths are 253, 255, 260, 277, 279, 280, 290, 293, 294, 314, 343 and 364 mV/cm.

When a series of EMFs are applied to a yeast culture, the yeast culture can remain in the same container while the same set of EMF generator and
30 emitters is used to change the frequency and/or field strength. The EMFs in the series can each have a different frequency or a different field strength; or a different frequency and a different field strength. Such frequencies and field strengths are

preferably within the above-described ranges. Although any practical number of EMFs can be used in a series, it may be preferred that the yeast culture be exposed to a total of, for example, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 or more EMFs in a series. In one embodiment, the yeast culture is exposed to a series of EMFs,

5 wherein the frequency of the electric field is alternated in the range of 9500-10500, 11700-12700 and 12200-13200 MHz.

Although the yeast cells can be activated after even a few hours of culturing in the presence of an EMF, it may be preferred that the activated yeast cells be allowed to multiply and grow in the presence of the EMF(s) for a total of

10 10-50 hours.

Fig. 1 illustrates an exemplary apparatus for generating alternating electric fields. An electric field of a desired frequency and intensity is generated by an AC source (3) capable of generating an alternating electric field, preferably in a sinusoidal wave form, in the frequency range of 10 to 20,000 MHz. Signal generators capable of generating signals with a narrower frequency range can also be used. If desirable, a signal amplifier can also be used to increase the output.

15 The activation container (2) can be made from non-conductive material, e.g., plastics, glass or ceramic. The wire connecting the activation container (2) and the signal generator (3) is preferably a high frequency coaxial cable with a transmission frequency of at least 30 GHz.

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The alternating electric field can be applied to the culture by a variety of means, including placing the yeast culture (1) in close proximity to the signal emitters such as a metal wire or tube capable of transmitting EMFs. The metal wire or tube can be made of red copper, and be placed inside the container (2), reaching as deep as 3-30 cm. For example, if the fluid in the container (2) has a depth of 15-20 cm, 20-30 cm, 30-50 cm, 50-70 cm, 70-100 cm, 100-150 cm or 150-200 cm, the metal wire can be 3-5 cm, 5-7 cm, 7-10 cm, 10-15 cm, 15-20 cm, 20-30 cm and 25-30 cm from the bottom of the container (2), respectively. The number of electrode wires used depends on the volume of the culture as well as the diameter of the wires. The number of metal wires/tubes used can be from 1 to 10 (e.g., 2 to 3). It is recommended, though not mandated, that for a culture having a volume up to 10 L, metal wires/tubes having a diameter of 0.5 to 2.0 mm be used.

For a culture having a volume between 10 L and 100 L, metal wires/tubes having a diameter of 3.0 to 5.0 mm can be used. For a culture having a volume in the range of 100-1000 L, metal wires/tubes having a diameter of 6.0 to 15.0 mm can be used. For a culture having a volume greater than 1000 L, metal wires/tubes having a 5 diameter of 20.0 to 25.0 mm can be used.

In one embodiment, the electric field is applied by electrodes submerged in the culture (1). In this embodiment, one of the electrodes can be a metal plate placed on the bottom of the container (2), and the other electrode can comprise a plurality of electrode wires evenly distributed in the culture (1) so as to 10 achieve even distribution of the electric field energy. The number of electrode wires used depends on the volume of the culture as well as the diameter of the wires.

III. Culture Media

Culture media useful in this invention contain sources of nutrients 15 assimilable by yeast cells. Complex carbon-containing substances in a suitable form, such as carbohydrates (e.g., sucrose, glucose, fructose, dextrose, maltose, xylose, cellulose, starches, etc.) and coal, can be the carbon sources for yeast cells. The exact quantity of the carbon sources utilized in the medium can be adjusted in accordance with the other ingredients of the medium. In general, the amount of 20 carbohydrates varies between about 0.1% and 10% by weight of the medium and preferably between about 0.1% and 5% (e.g., about 2%). These carbon sources can be used individually or in combination. Amino acid-containing substances in suitable form (e.g., beef extract and peptone) can also be added individually or in combination. In general, the amount of amino acid containing substances varies 25 between about 0.1% and 0.5% by weight of the medium and preferably between about 0.1% and 0.3% (e.g., about 0.25%). Among the inorganic salts which can be added to the culture medium are the customary salts capable of yielding sodium, potassium, calcium, phosphate, sulfate, carbonate, and like ions. Non-limiting examples of nutrient inorganic salts are $(\text{NH}_4)_2\text{HPO}_4$, KH_2PO_4 , K_2HPO_4 , CaCO_3 , 30 MgSO_4 , NaCl , and CaSO_4 .

IV. Electromagnetic Activation of Yeast Cells

To activate or enhance the ability of yeast cells to produce substances beneficial for the treatment of gastroparesis (e.g., stimulating stomach contraction), these cells can be activated by being cultured in an appropriate medium under sterile conditions at 20°C-38°C, preferably at 28-32°C (e.g., 30°C) 5 for a sufficient amount of time, e.g., 10-50 hours, in an alternating electric field or a series of alternating electric fields as described above.

An exemplary culture medium is made by mixing 1000 ml of distilled water with 18 g of mannitol, 20 µg of vitamin B₁₂, 40 µg of vitamin B₆, 10 µg of vitamin D, 35 ml of fetal bovine serum, 0.20 g of KH₂PO₄, 0.25 g of 10 MgSO₄•7H₂O, 0.3 g of NaCl, 0.2 g of CaSO₄•2H₂O, 4.0 g of CaCO₃•5H₂O, and 2.5 g of peptone.

An exemplary set-up of the culturing process is depicted in Fig. 1. Untreated yeast cells are added to a culture medium at 1x10⁸ cells per 1000 ml of the culture medium. The yeast cells may be *Saccharomyces cerevisiae* Hansen 15 AS2.559, or may be selected from any of the strains listed in Table 1. An exemplary activation process of the yeast cells involves the following sequence: the yeast cells are grown in the culture medium for 23-43 hours (e.g., 28 hours) at 28-32°C and then exposed to (1) an alternating electric field having a frequency of 10012 MHz and a field strength in the range of 240-260 mV/cm (e.g., 255 mV/cm) 20 for 7-17 hours (e.g., 12 hours); (2) then to an alternating electric field having a frequency of 10038 MHz and a field strength in the range of 235-255 mV/cm (e.g., 253 mV/cm) for 31-41 hours (e.g., 36 hours); (3) then to an alternating electric field having a frequency of 12177 MHz and a field strength in the range of 265-285 mV/cm (e.g., 277 mV/cm) for 36-46 hours (e.g., 41 hours); (4) then to an 25 alternating electric field having a frequency of 12712 MHz and a field strength in the range of 290-310 mV/cm (e.g., 294 mV/cm) for 20-30 hours (e.g., 25 hours); and (5) finally to an alternating electric field having a frequency of 12733 MHz and a field strength in the range of 255-275 mV/cm (e.g., 260 mV/cm) for 10-20 hours (e.g., 15 hours). The activated yeast cells are then recovered from the culture 30 medium by various methods known in the art, dried (e.g., by lyophilization) and stored at about 4°C in powder form. The resultant yeast powder preferably contains no less than 10¹⁰ cells/g activated yeast.

Subsequently, the activated yeast cells can be evaluated for their ability to treat gastroparesis using standard methods known in the art, such as those described in Section VII.

V. Acclimatization of Yeast Cells To the Gastric Environment

5 Because the activated yeast cells of this invention must pass through the stomach before reaching the small intestine, where the effective components are released from these yeast cells, it is preferred that these yeasts be cultured under acidic conditions so as to acclimatize the cells to the gastric juice. This acclimatization process results in better viability of the yeast cells in the acidic
10 gastric environment.

To achieve this, the yeast powder containing activated yeast cells can be mixed with a highly acidic acclimatizing culture medium at 10 g (containing more than 10^{10} activated cells per gram) per 1000 ml. The yeast mixture can then be cultured first in the presence of an alternating electric field having a frequency
15 of 12712 MHz and a field strength in the range of 290-320 mV/cm (e.g., 314 mV/cm) at about 28 to 32°C for 36-42 hours (e.g., 38 hours). The resultant yeast cells can then be further incubated in the presence of an alternating electric field having a frequency of 12733 MHz and a field strength in the range of 275-295 mV/cm (e.g., 290 mV/cm) at about 28 to 32°C for 16-28 hours (e.g., 20 hours).
20 The resulting acclimatized yeast cells are then recovered from the culture medium by various methods known in the art and are dried and stored either in powder form ($\geq 10^{10}$ cells/g) at room temperature or in vacuum at 0-4°C.

An exemplary acclimatizing culture medium is made by mixing 700 ml fresh pig gastric juice and 300 ml wild Chinese hawthorn extract. The pH of
25 acclimatizing culture medium is adjusted to 2.5 with 0.1 M hydrochloric acid (HCl) and 0.2 M potassium hydrogen phthalate ($C_6H_4(COOK)COOH$). The fresh pig gastric juice is prepared as follows. At about 4 months of age, newborn Holland white pigs are sacrificed, and the entire contents of their stomachs are retrieved and mixed with 2000 ml of water under sterile conditions. The mixture is then allowed
30 to stand for 6 hours at 4°C under sterile conditions to precipitate food debris. The supernatant is collected for use in the acclimatizing culture medium. To prepare the wild Chinese hawthorn extract, 500 g of fresh wild Chinese hawthorn is dried

under sterile conditions to reduce water content ($\leq 8\%$). The dried fruit is then ground (≥ 20 mesh) and added to 1500 ml of sterile water. The hawthorn slurry is allowed to stand for 6 hours at 4°C under sterile conditions. The hawthorn supernatant is collected to be used in the acclimatizing culture medium.

5 **VI. Manufacture of Yeast Compositions**

To prepare the yeast compositions of the invention, an apparatus depicted in Fig. 2 or an equivalent thereof can be used. This apparatus includes three containers, a first container (A), a second container (B), and a third container (C), each equipped with a pair of electrodes (4). One of the electrodes is a metal plate placed on the bottom of the containers, and the other electrode comprises a plurality of electrode wires evenly distributed in the space within the container to achieve even distribution of the electric field energy. All three pairs of electrodes are connected to a common signal generator.

The culture medium used for this purpose is a mixed fruit extract solution containing the following ingredients per 1000 L: 300 L of wild Chinese hawthorn extract, 300 L of jujube extract, 300 L of *Schisandra chinensis* (Turez) *Baill* seeds extract, and 100 L of soy bean extract. To prepare hawthorn, jujube and *Schisandra chinensis* (Turez) *Baill* seeds extracts, the fresh fruits are washed and dried under sterile conditions to reduce the water content to no higher than 8%. One hundred kilograms of the dried fruits are then ground (≥ 20 mesh) and added to 400 L of sterilized water. The mixtures are stirred under sterile conditions at room temperature for twelve hours, and then centrifuged at 1000 rpm to remove insoluble residues. To make the soy bean extract, fresh soy beans are washed and dried under sterile conditions to reduce the water content to no higher than 8%. Thirty kilograms of dried soy beans are then ground into particles of no smaller than 20 mesh, and added to 130 L of sterilized water. The mixture is stirred under sterile conditions at room temperature for twelve hours and centrifuged at 1000 rpm to remove insoluble residues. Once the mixed fruit extract solution is prepared, it is autoclaved at 121°C for 30 minutes and cooled to below 40°C before use.

One thousand grams of the activated yeast powder prepared as described above (Section V, *supra*) is added to 1000 L of the mixed fruit extract

solution, and the yeast solution is transferred to the first container (A) shown in Fig. 2. The yeast cells are then cultured in the presence of an alternating electric field having a frequency of 12712 MHz and a field strength of about 360-380 mV/cm (e.g., 364 mV/cm) at 28-32°C under sterile conditions for 19-29 hours

5 (e.g., 24 hours). The yeast cells are further incubated in an alternating electric field having a frequency of 12733 MHz and a field strength of 280-300 mV/cm (e.g., 293 mV/cm). The culturing continues for 7-17 hours (e.g., 12 hours).

The yeast culture is then transferred from the first container (A) to the second container (B) (if need be, a new batch of yeast culture can be started in

10 the now available the first container (A)), and subjected to an alternating electric field having a frequency of 12712 MHz and a field strength of 265-285 mV/cm (e.g., 279 mV/cm) for 19-29 hours (e.g., 24 hours). Subsequently the frequency and field strength of the electric field are changed to 12733 MHz and 250-270 mV/cm (e.g., 260 mV/cm), respectively. The culturing process continues for 7-17

15 hours (e.g., 12 hours).

The yeast culture is then transferred from the second container (B) to the third container (C), and subjected to an alternating electric field having a frequency of 12712 MHz and a field strength of 265-285 mV/cm (e.g., 279 mV/cm) for 19-29 hours (e.g., 24 hours). Subsequently the frequency and field

20 strength of the electric field are changed to 12733 MHz and 250-270 mV/cm (e.g., 260 mV/cm), respectively. The culturing continues for 7-17 hours (e.g., 12 hours).

The yeast culture from the third container (C) can then be packaged into vacuum sealed bottles for use as dietary supplement or medication. The compositions may be conveniently formulated as health drinks. If desired, the final

25 yeast culture can also be dried within 24 hours and stored in powder form. The dietary supplement or medication can be taken three to four times daily at 30~50 ml or 100 ml per bottle for a three-month period (preferably a six-month period), preferably 10-30 minutes before meals and at bedtime.

In some embodiments, the compositions of the invention can also be

30 administered intravenously or peritoneally in the form of a sterile injectable preparation. Such a sterile preparation can be prepared as follows. A sterilized health drink composition is first treated under ultrasound (≥ 18000 Hz) for 10

minutes and then centrifuged at 4355 rpm for another 10 minutes. The resulting supernatant is adjusted to pH 7.2-7.4 using 1 M NaOH and subsequently filtered through a membrane (0.22 μ m for intravenous injection and 0.45 μ m for peritoneal injection) under sterile conditions. The resulting sterile preparation is submerged 5 in a 35-38°C water bath for 30 minutes before use. In other embodiments, the compositions of the invention may also be formulated with pharmaceutically acceptable carriers to be orally administered in any orally acceptable dosage form including, but not limited to, capsules, tablets, suspensions or solutions.

10 The yeast compositions of the present invention are derived from yeasts used in food and pharmaceutical industries. The yeast compositions are thus devoid of side effects associated with many pharmaceutical compounds.

VII. Examples

In order that this invention be more fully understood, the following examples are set forth. These examples are for the purpose of illustration only and 15 are not to be construed as limiting the scope of the invention in any way.

The activated yeast compositions used in the following examples were prepared as described above, using *Saccharomyces cerevisiae* Hansen AS2.559, cultured in the presence of an alternating electric field having the electric field frequency and field strength exemplified in the parentheses following the 20 recommended ranges listed in Section IV, *supra*. Control (i.e., untreated) yeast compositions were those prepared in the same manner as described in Section IV, *supra*, except that the yeast cells were cultured in the absence of EMFs. Unless otherwise specified, all compositions of interest were administered to the animals by intragastric feeding.

25 Example 1: Effects of Yeast Compositions on Stomach Contraction

To test the ability of the activated yeast compositions to stimulate stomach contraction, thirty domestic rabbits (*Oryctolagus curiculus*) of average weight of about 2.0 ± 0.2 kg (3-5 months old, half of them male and the other half female) were fasted for 16 hours and subsequently randomly divided into three 30 groups, designated as AY, NY and CK.

Each rabbit was anesthetized by injection of 0.8 ml of a 2.5 g/dl pentobarbital solution through its marginal ear vein. A No. 10 urinary catheter was

inserted into the stomach of the rabbit through its mouth (about 22 cm from its teeth) for feeding. See, e.g., Zhu Yu et al., Eds., Animal Disease Models, Tian Jin Science and Technology Translation Publishing Company (1997).

Each rabbit was then placed in a supine position on a rabbit board.

- 5 The fur around the xiphoid process or ensisternum was shaved and the exposed skin was rubbed with 95% alcohol to remove surface oil. An electrode was placed onto the rabbit's abdomen over the gastric antrum, which was about 1 cm below and 1 cm to the left of xiphoid process. Another electrode was placed over the stomach, which was about 1 cm below and 1 cm to the right of xiphoid process.
- 10 An electrogastrogram (EGG) was taken for 5 to 10 minutes first over gastric antrum and then over the stomach before the rabbits were fed.

Rabbits in the AY group were each given 2 ml of the activated yeast composition. Rabbits in the NY group were each given 2 ml of the control yeast composition. Rabbits in the CK group were each given 2 ml of saline. The rabbits 15 in all three groups were otherwise maintained under the same conditions. An EGG was taken for each rabbit, first over the gastric antrum and then over the stomach, at 30 minutes and 60 minutes after feeding.

A representative EGG before and after feeding for rabbits in each group is shown in Fig. 3. The average frequency (1/min.) and intensity (μ V) of 20 electrical signals recorded on EGGs over a period of 3 to 5 minutes are summarized in Table 2a and Table 2b, respectively.

Table 2a. Effects of Treatment on the Frequency of Electrical Signals

Time (min.)	Gastric Antrum			Stomach		
	AY	NY	CK	AY	NY	CK
25	0	2.7±0.6	2.8±0.5	2.8±0.6	2.1±0.5	2.3±0.6
	30	2.6±0.7	2.7±0.5	2.7±0.8	2.4±0.5	1.8±0.6
	60	2.9±0.2	2.7±0.7	2.7±0.6	2.1±0.4	2.7±0.5

Table 2b. Effects of Treatment on the Intensity of Electrical Signals

Time (min.)	Gastric Antrum			Stomach			
	AY	NY	CK	AY	NY	CK	
5	0	112±67.6	107±59.8	115±71.2	29.3±9.7	23.7±10.6	25.8±11.3
	30	242±37.6	122±32.5	127±33.8	52.5±22.6	31.1±1.1	30.2±0.8
	60	157±17.3	121±39.6	125±41.8	58.4±10.6	24.6±0.7	25.4±0.5

The above results show that unlike the control yeast composition or saline, the activated yeast composition could stimulate the stomach to contract by increasing the intensity of the electrical signals over both the gastric antrum and the stomach.

Example 2: Effects of the Treatment on Gastric Acid and Pepsin

Thirty Wistar rats of average weight of about 180-200 g (4-6 months old) were randomly divided into three equal groups. Rats in the AY group were administered 2 ml of the activated yeast composition once daily for five days. Rats in the NY and CK groups were given 2 ml of the control yeast composition and saline once daily for five days, respectively. The rats in all three groups were otherwise maintained under the same conditions.

After the fifth dose of yeast composition was administered to the animals, the animals were given only water, but no food, for the next 24 hours. The rats were then anesthetized with ether. An incision was then made in the middle of the abdomen of the animal and the stomach was located. The pylorus was then ligated. The activated yeast composition, control yeast composition, and saline were administered at 3 ml/kg body weight through the duodenum by injection to rats in the AY, NY and CK groups, respectively. Then, the incision was stitched. Two hours later, the animals were sacrificed. The whole stomach was removed. The gastric contents were emptied into a conical centrifuge tube, measured for its volume and pH value, and centrifuged at 1500 rpm for 10 minutes. The supernatant was collected.

The pepsin concentration in the gastric juice was determined by the HPLC method.

The experimental results are summarized in Table 3 below.

Table 3. Effects of Treatment on Secretion of Gastric Acid and Pepsin Activity

Group	Gastric Juice (ml)	Gastric Acid (μ M)	Pepsin Activity (μ M)
CK	11.2 \pm 2.1	1.2 \pm 0.5	92.2 \pm 23.3
5 NY	10.7 \pm 2.2	1.1 \pm 0.4	91.7 \pm 22.4
AY	4.8 \pm 1.8	0.4 \pm 0.2	43.6 \pm 13.6

These data demonstrate that the activated yeast composition decreased gastric acid concentration and pepsin activity, as compared to the control yeast composition and saline.

10 While a number of embodiments of this invention have been set forth, it is apparent that the basic constructions may be altered to provide other embodiments which utilize the compositions and methods of this invention.